What Is Claimed Is:

1. A plate frame heat exchange reactor assembly comprising:

a plurality of header sheets, each of said plurality of header sheets having a plurality of manifold ports;

a heat transfer surface contained within a central region of each of said plurality of header sheets;

a plurality of interleaved sheets, one of said plurality of interleaved sheets being located between each adjacent pair of said plurality of header sheets, wherein each of said plurality of interleaved sheets having a plurality of interleaved manifold ports;

one of said plurality of interleaved sheets and an adjacent one of said plurality of header sheets defines a cell;

a feed gas inlet manifold port for directing a feed gas into the assembly;

a burner feed inlet manifold port for directing a burner feed gas into the assembly;

a reformer section coupled to said feed gas inlet manifold port so as to receive a stream of feed gas from said feed gas inlet manifold, said reformer section converting said stream of feed gas to a stream of reformed stream gas, said reformer section having a plurality of reformer channels, each of said reformer channels being formed between every other of said cells, wherein each of said reformer channels is coupled to said adjacent reformer channel through at least one of said plurality of manifold ports and at

least one of said plurality of interleaved manifold ports;

a burner gas section coupled to the burner feed inlet manifold so as to receive heated burner exhaust, said burner gas section having a plurality of burner channels, each of said burner channels being formed between the other of every other of said cells, wherein each of said burner channels is coupled to said adjacent burner channel through one of said plurality of interleaved manifold ports and one of said plurality of manifold ports;

an outlet manifold coupled to said reformer section for removing reformed feed gas from the assembly;

a burner outlet manifold coupled to said burner section for removing cooled burner exhaust from the assembly; and,

wherein said feed gas flow and said exhaust burner gas flow is substantially perpendicular with respect to one another between a pair of adjacent cells and wherein said feed gas flow and said exhaust gas flow are substantially cross-flow with respect to one another in said reformer section and said burner section.

2. The assembly of claim 1, further comprising a second inlet manifold port coupled to one of said reformer channels between one of said plurality of header sheets and one of said plurality of interleaved sheets.

3. The assembly of claim 1, wherein a thin layer of catalyst is coated on each of said heat

transfer surfaces and on each of said plurality of interleaved sheets.

4. The assembly of claim 3, wherein said thin layer of catalyst comprises a layer of γ-alumina powder with a dispersed catalytic metal adhered to a superalloy.

5. The assembly of claim 3, wherein said thin layer of catalyst comprises a layer of γ-alumina powder with a dispersed catalytic metal adhered to a stainless steel structure.

6. The assembly of claim 1, wherein each of said header sheets are brazed to each of said adjacent interleaved sheets.

7. The assembly of claim 1 further comprising at least one parallel zone interspersed within the assembly, said at least one parallel zone comprising:

at least one second reformer section coupled to a third inlet manifold port so as to receive a third stream of feed gas from said feed gas inlet manifold port, said at least one second reformer section converting said third stream of feed gas to a third stream of reformed stream gas, each of said at least one second reformer section having a second reformer channel, each of said second reformer channels being formed between one of a plurality of second header sheets and an adjacent one of said plurality of second interleaved sheets, wherein said second reformer channel is connected to said outlet manifold; and

at least one second burner gas section coupled to said burner feed inlet manifold so as to receive a second stream of burner feed gas, each of said at least one second burner gas sections having a second burner channel formed between one of said plurality of second header sheets and the other adjacent one of said plurality of second interleaved sheets, wherein each of said second burner channels is coupled to said burner outlet manifold;

wherein the flow of said third stream of feed gas and the flow of said second stream of burner feed gas through said at least one parallel zone are substantially parallel and either in a co-flow or counterflow configuration with respect to one another.

8. A plate frame heat exchange reactor assembly comprising:

a plurality of header sheets, each of said plurality of header sheets having a plurality of manifold ports;

a heat transfer surface contained within a central region of each of said plurality of header sheets;

a plurality of interleaved sheets, wherein one of said plurality of interleaved sheets being located between each adjacent pair of said plurality of header sheets, each of said plurality of interleaved sheets having a plurality of interleaved manifold ports;

wherein one of said plurality of interleaved sheets and an adjacent one of said plurality of header sheets defines a cell;

a feed gas inlet manifold port for directing a feed gas into the assembly;

a burner feed inlet manifold port for directing a burner feed gas into the assembly;

a reformer section coupled to said feed gas inlet manifold port so as to receive a stream of feed gas from said feed gas inlet manifold, said reformer section converting said stream of feed gas to a stream of reformed stream gas, said reformer section having a plurality of reformer channels,;

wherein at least two of said plurality of reformer channels are coupled together to form a coupled reformer channel, wherein each of said coupled reformer channels is coupled to the next adjacent one of said coupled reformer channels through at least one of said plurality of manifold ports and at least one of said plurality of interleaved manifold ports;

a burner gas section coupled to the burner feed inlet manifold so as to receive heated burner exhaust, said burner gas section having a plurality of burner channels;

wherein at least two of said plurality of burner channels are coupled to together to form a coupled burner channel, wherein each of said coupled burner is coupled to the next adjacent one of said coupled burner channels through at least one of said plurality of manifold ports and at least one of said plurality of interleaved manifold ports;

an outlet manifold coupled to said reformer section for removing reformed feed gas from the assembly;

a burner outlet manifold coupled to said burner section for removing cooled burner exhaust from the assembly;

wherein said feed gas flow in said coupled reformer channel and said exhaust burner gas flow in said next adjacent coupled burner channel are substantially perpendicular with respect to one another;

wherein said feed gas flow in said coupled reformer channel and said feed gas flow in a next adjacent of said coupled reformer channels flow in opposite directions with respect to one another; and

wherein said burner gas flow in said coupled burner channel and said burner gas flow in a next adjacent of said coupled burner channels flow in opposite directions with respect to one another;

wherein said feed gas flow and said exhaust gas flow are substantially cross-flow with respect to one another in said reformer section and said burner section.

9. The assembly of claim 8, further comprising a second inlet manifold port coupled to one of said reformer channels between one of said plurality of header sheets and one of said plurality of interleaved sheets.

10. The assembly of claim 8, wherein a thin layer of catalyst is coated on each of said heat transfer surfaces and on each of said plurality of interleaved sheets.

11. The assembly of claim 10, wherein said thin layer of catalyst comprises a layer of γ-alumina powder with a dispersed catalytic metal.

12. The assembly of claim 10, wherein said thin layer of catalyst comprises a layer of γ-alumina powder with a dispersed catalytic metal adhered to a stainless steel structure adhered to a superalloy.

13. The assembly of claim 8, wherein each of said header sheets are brazed to each of said adjacent interleaved sheets.

14. The assembly of claim 8 further comprising at least one parallel zone interspersed within the assembly, said at least one parallel zone comprising:

at least one second reformer section coupled to a third inlet manifold port so as to receive a third stream of feed gas from said feed gas inlet manifold port, wherein said at least one second reformer section converting said third stream of feed gas to a third stream of reformed stream gas, each of said at least one second reformer section having a second reformer channel, each of said second reformer channels being formed between one of a plurality of second header sheets and an adjacent one of said plurality of second interleaved sheets, wherein said second reformer channel is connected to said outlet manifold;

at least one second burner gas section coupled to said burner feed inlet manifold so as to receive a second stream of burner feed gas, each of said at least one second burner gas sections having a

second burner channel formed between one of said plurality of second header sheets and the other adjacent one of said plurality of second interleaved sheets, wherein each of said second burner channels is coupled to said burner outlet manifold; and

wherein the flow of said third stream of feed gas and the flow of said second stream of burner feed gas through said at least one parallel zone are substantially parallel and either in a co-flow or counterflow configuration with respect to one another.

15. A method for optimizing heat transfer, mass transfer and pressure drop in a plate-frame heat-exchange reactor having an feed gas inlet manifold for receiving a stream of feed gas, a reformer section connected to the feed gas inlet manifold for converting the feed gas to a reformed feed gas, a feed gas outlet manifold coupled to the reformer section for expelling a stream of reformed feed gas, a burner inlet manifold for receiving burner exhaust, a burner section coupled to the reformer section for cooling the burner exhaust, and a burner outlet manifold for expelling the cooled burner exhaust, the method comprising the steps of:

increasing flow velocity of the feed gas within the plate-frame heat exchange reactor;

increasing laminar flow of the feed gas within the plate-frame heat exchange reactor.

16. The method of claim 15 further comprising the step of:

introducing a second quantity of feed gas at a first position within the plate-frame exchange reactor, wherein said first position is located between

the feed gas intake manifold and the feed gas outlet manifold.

17. The method of claim 15, wherein the steps of increasing flow velocity of the feed gas within the plate-frame heat exchange reactor and increasing laminar flow of the feed gas within the plate-frame heat exchange reactor comprises the step of:

coupling the reformer section and the adjacent burner section such that the flow of feed gas through said reformer section and the flow of burner exhaust through in said adjacent burner section are substantially perpendicular with respect to one another, wherein the overall flow between said reformer section and said burner section is substantially serial counterflow.

18. The method of claim 15, wherein the steps of increasing flow velocity of the feed gas within the plate-frame heat exchange reactor and increasing laminar flow of the feed gas within the plate-frame heat exchange reactor comprises the steps of:

coupling a plurality of reformer sections to form a coupled reformer section;

coupling a plurality of burner sections to form a coupled burner section;

coupling said coupled reformer section and said coupled burner section such that the flow of feed gas through said coupled reformer section and the flow of burner exhaust through said next adjacent coupled burner exhaust section are substantially perpendicular

with respect to one another, wherein the overall flow between said plurality of coupled reformer sections and said plurality of coupled burner sections is substantially serial counterflow.